14 ~~44~~. The device of claim 12 ~~42~~ wherein the semiconductor layers form a light emitting diode.

15 ~~43~~. The device of claim 12 ~~42~~ wherein the wafer-bond layer is a transparent substrate having a thickness greater than 8 mil, the transparent substrate being wafer bonded to the semiconductor wafers.

cont'd D3

16 ~~46~~. The device of claim 12 ~~42~~ further comprising a second optically transparent wafer-bond layer coupled to the semiconductor layers.

REMARKS

In the parent case, claims 14 through 21 were rejected under 35 U.S.C. §103 as being unpatentable over Fletcher et al., U.S. Patent No. 5,008,718("Fletcher") in view of Jokerst et al., U.S. Patent No. 5,280,184("Jokerst").

In this continuation application, claim 14 has been amended and new claims 38 through 46 added. Applicants believe that both the amended claims and the newly entered claims distinguish over the both Fletcher and Jokerst. Additionally, they believe that certain objections by the Examiner in the parent case relating to the term "robust" are answered herein.

The Examiner in the parent case objected to the term "robust" in amended claim 14 of the parent application under 35 U.S.C. §112, second paragraph as being indefinite. Presumably, the use of the term would also be objected to in new claims 42 through 46. The Examiner further stated that the term is purely qualitative. Applicants disagree respectfully with this conclusion and believe that they can show that the term has a known and commonly used meaning in this field.

The term "robust" was used in this application in a manner consistent with how it is commonly used in this field. A "robust" LED is a device that can be fabricated and packaged, surviving all standard processing steps, and then remains functional despite various forms of environmental stress. Standard fabrication steps include chemical etching, plasma etching, solvent cleaning, dielectric deposition, metal deposition by means of sputtering, evaporation,

etc., diffusion, elevated temperature alloying, wafer dicing or scribing, die testing and probing, die bonding, wire bonding, and epoxy encapsulation. These techniques are described in many technical books used and accepted in the art, including K. Gillessen and W. Schairer, Light Emitting Diodes, Prentice Hall, Englewood Cliffs, N.J., 1987, pp. 57-102, A.A. Bergh and P.J. Dean, Light Emitting Diodes, Oxford, Clarendon, 1976, pp. 385-572, and Craford, M.G., Flat-Panel Displays and CRTs, ed. By L.E. Tannas, Jr., Van Nostrand Reinhold, New York, pp. 306-319, and 324-327.

It should be noted that the minimal definition accepted in the art is consistent with that given in the American Heritage Dictionary, " ROBUST...powerfully built; sturdy", or, in the present application, able to be built or fabricated.

Given that the term "robust" has a commonly accepted, quantifiable definition in this field, applicants are simply requesting that the Examiner accept this definition of the term as commonly used in the field of light emitting diode design and their manufacture.

This definition was referred to specifically on page 22 of the present application, wherein the limitations of van der Waals bonding were discussed. "...the van der Waals bond does not generally provide sufficient mechanical strength and does not generally provide sufficient electrical conductivity to be employed in LED device fabrication..."

As the term "robust" is therefore not purely qualitative and as one of ordinary skill in the art would be aware of what a "robust" wafer bond would be, applicants respectfully ask that this ground of rejection in the parent case be removed.

Fletcher was cited in the parent case as teaching an LED with transparent GaP substrate. The Examiner admitted, however, that nothing in Fletcher teaches anything relating to wafer bonding or wafer bonds. Applicants herein are not claiming that the particular material system used to fabricate the light emitting semiconductor device disclosed in the present invention is unique. Therefore, they readily concede that the material system shown in Fletcher is similar to that used in the present invention. However, the use of an optically transparent wafer bond in an LED device structure is central to each of the independent claims presented by this application. Fletcher provides absolutely no teaching on this aspect of the present invention.

Jokerst et al., U.S. Patent No. 5,280,184("Jokerst") teaches nothing about the

fabrication of an LED with a wafer bond and suggests only two ways to bond semiconductor surfaces together. These are by using van der Waals(electrostatic) forces or metal-to-metal bonding. Neither of these types of bonding produces simultaneously both a transparent and a conductive wafer bond, as is claimed in claims 14 and 38 of the present application, and the claims dependent thereon. Jokerst specifically states that a metal-to-metal bond forms a much better electrical bond than "merely a van der Waals bond"(Jokerst, col. 11, lines 61-63). It is commonly known in the art that the van der Waals bond is essentially insulating and does not conduct current unless light absorbing metal layers are employed at the van der Waals bonded interface.

Unfortunately, the metal-to-metal bond recommended by Jokerst to improve electrical conductivity is not transparent. Van der Waals bonds lack both mechanical strength and electrical conductivity. Jokerst only teaches methods of an optically transparent but mechanically weak and non-conducting van der Waals bond or an electrically conductive but optically absorbing metallurgical bond. These properties are mutually exclusive in Jokerst. There is in particular no teaching for an electrically conductive, optically transparent wafer bond as set forth in new claims 38 through 41. In particular, the optically transparent, electrically conductive wafer bond taught in the present invention(claims 38-41) is directly between two layers of semiconductor materials. Jokerst requires a metal layer between the semiconductor layers to provide a conductive bond.

The only optically transparent wafer-bond taught by Jokerst is a van der Waals bond, which is sometimes referred to as an electrostatic bond. The present application readily distinguishes over Jokerst in that techniques taught in the present application permit the wafer-bond to be of sufficient strength so that the LEDs can survive device fabrication while the wafer-bonded interface maintains its optical transparency. This distinction is made on page 8 of the present application: " It has been discovered that van der Waals' forces are typically ineffective in obtaining the desired ohmic characteristics and structural integrity". Claims 14 through 17, 19 through 21 and 42 through 46 are therefore distinguishable from Jokerst in that the wafer bond is robust, unlike the van der Waals bond.

As all pending claims are distinguishable over the previously cited prior art, and as the objection to the term "robust" has been answered, applicants request review and allowance of

the pending claims in this application.

Respectfully submitted,

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